Partial Translation of CN1094827A

(Description on page 3, the third paragraph to page 5, the second paragraph from the bottom)

3. A positioning bolt is employed to achieve an alignment of two sides: herein, two mask plates are positioned by using the positioning bolt. Specifically, plate A of the two mask plates is fabricated at first, and then plate A is tightened with the other plate B to be fabricated by the positioning bolt. The two plates which are symmetrical with each other are obtained by exposing B through A. In operation, the silicon wafer coated with resists at both sides is disposed between the two mask plates. The two mask plates are positioned and tightened by the positioning bolt according to the orientation by which the two mask plates are fabricated. A single side can be exposed to the light in turn, or both sides can be exposed to the light at the same time, and then the etching is performed. See, RICHARD M. WHITE et al., "Sensor and Actuators", 13 (1988) pp. 391-395.

Disadvantages of this method are as follows:

(1) The positioning of the silicon wafer depends on the positioning bolt, so the silicon wafer is required to have a positioning plane with adequate length. Therefore, this not only increases the demand of processing of the silicon wafer, but also decreases the use ratio of the silicon wafer;

(2) The minute fluctuation of the diameter of the positioning bolt, especially the minute deviation of the

installation perpendicularity degree, may cause the misalignment of the patterns of the two mask plates when the silicon wafer is sandwiched therebetween;

(3) The pattern arrangement on the silicon wafer must be strictly parallel to the positioning plane, which increases the difficulty of fabricating the plate;

(4) This method is only used for the double-sided register exposure on the bare wafer with no patterns after one time of oxidation, which cannot achieve the alignment between the patterns on the mask plates and the patterns on the wafer.

4. Mechanical double-sided lithography tool: The key point of this lithography tool is that it is provided with a double-sided exposure fixture. The upper plate is fixed on the plate fixture which can be moved in a three-dimensional direction of X, Y and Z, and the lower plate can be moved up and down and rotated around a concentric axis. Both the two plates have the alignment marks. In operation, the silicon wafer is disposed between the two plates which can be aligned with the marks, and the exposure can be performed by using an upper light source and a lower light source simultaneously. See, Mingrui. PAN, "Semiconductor Technology", January 1987, pp. 7.

Disadvantages of this method are as follows:

(1) The silicon wafer cannot be moved freely between the two mask plates, and this method is also only used for the exposure on the silicon wafer with no patterns after one time of oxidation;

(2) When aligning the two mask plates, it is required to discern the marks on the two mask plates, therefore the requirement of the field depth of a microscope is much

higher. Further, when the thickness of the silicon wafer exceeds 400um, one lens of the ocular needs to be rebuilt. Since the alignment marks of the upper and lower mask plates are observed through two oculars with different amplify factors, the two alignment marks seen by eyes are not same in size. It is obvious that it is difficult to align accurately using the naked eyes, and the human factor is increased;

(3) Since the positioning of the orientation of single wafer cannot be achieved, it cannot be used for the register exposure when employing an anisotropy etching.

One object of the present invention is to provide a novel principle of an exposure machine which enables an accurate alignment of an upper mask plate and a lower mask plate, whose alignment deviation is less than 10 micrometers, such that the double-sided alignment exposure can be achieved; another object of the present invention is to provide a double-sided register exposure machine, which is simple in structure, low in cost, and easy to operate.

The inventive double-sided register exposure machine includes:

a microscope 2 mounted around a vertical axis fixed onto a desk frame 12, which can be rotated horizontally around the axis and moved up and down along the axis; and

an upper light source 11 used for exposure, which is a parallel light source formed by a normal electrical light source, wherein the light source is disposed on the same vertical axis with the microscope 2 at a fixed angle, the up and down height of the light source is adjustable and the light source can be rotated horizontally around the axis.

The features of this invention further include:

an upper mask plate sucking disc 3 disposed on a worm which can be shifted vertically through a cantilever, wherein the turbine worm system is fixed on a support frame which can be rotated around a main axis fixed on the desk frame 12, the upper sucking disc 3 has an annular column cavity structure, the upper and lower end surfaces of which have been polished into mirror surfaces, and the lower end surface is provided with pore group 13 wherein the pores are in a symmetrical distribution, an air tap 14 is provided on the side to connect the cavity with an extraction pump, a negative pressure can be formed in the cavity 15 by the extraction pump through the air tap to absorb and fix the upper mask plate 4 onto the sucking disc 3 through the pore group 13, and then the upper mask plate 4 can be rotated around the axis and moved up and down along the axis;

a silicon wafer sucking disc 6 having a column cavity structure, the upper end surfaces of which has been polished into mirror surface and is provided with small pore group 16, wherein an air tap 17 is disposed on the side to connect the cavity with an extraction pump, a negative pressure can be formed in the cavity by the extraction pump through the air tap to absorb and fix a silicon wafer onto the upper end surface of the sucking disc 6, the sucking disc 6 is disposed on the desk frame 12 and can be horizontally inched along X or Y direction and horizontally spun;

a lower mask plate sucking disc 8 having the same structure as the upper mask plate sucking disc 8, the upper end surfaces of which has been polished into mirror surface

and is provided with small pore group in a symmetrical distribution, wherein the sucking disc 8 is provided on the desk frame and can be horizontally inched along X or Y direction and horizontally spun; and

a lower light source baffle 9 and a lower light source 10, wherein the baffle 9 is coaxially installed and can be moved together with the upper light source 11, and the lower light source 10 is also a parallel light source formed by a normal electrical light source and vertically located below the lower mask plate sucking disc 8 underneath the desk frame 12.

In operation, firstly, two mirror symmetric (with patterns or certain marks) mask plates are placed on the lower mask plate sucking disc with the surfaces having the resist films to be opposed each other, then the lower mask plate is absorbed by turning on the vacuum path for the lower mask plate; and then the upper mask plate is absorbed and lift by dropping down the upper mask plate sucking disc, the distance between the two mask plates is limited to an extent that it just can not bring any friction between the resist films. The lower mask plate is shifted and rotated under the microscope to make it absolutely align with the alignment marks of the upper mask plate. After the operation described above, both the two plate can not have any horizontal inching (slightly moving). Next, the upper fixture is lifted to a height that is limited to an extent that the sucking disc with a silicon wafer can be provided between the two mask plates. The upper sucking disc is dropped down after the silicon wafer has been provided between the two mask plates, making the upper mask plate slightly contact the silicon wafer, then the silicon

wafer is shifted and rotated to make it align with the patterns of the upper mask plate. Then, the upper sucking disc is covered by an upper lid to make the upper mask plate and the cavity within the sucking disc connect with the vacuum system, the silicon wafer is absorbed onto the lower surface of the upper mask plate by the pores of the upper mask plate, the gas in the gas line of the wafer sucking disc is released, the upper mask plate is lifted up at this moment, and the silicon wafer is lifted up together with the upper mask plate. Next, the silicon wafer frame is withdrawn, and the upper mask sucking disc is dropped down until the lower surface of the silicon wafer contacts the lower mask plate. Next, the upper lid of the upper sucking disc is opened, the microscope is rotated away, the silicon wafer is exposed to the light with the upper light source aligning it, and at the same time, the lower baffle is rotated away, the silicon wafer is exposed to the light with the lower light source aligning the lower surface of it. The patterns whose front and back side are aligned can be achieved after development.

[19]中华人民共和国专利局

[11] 公开号 CN 1094827A

M358-CN

[12] 发明专利申请公开说明书

[21]申请号 93105471.0

[51]Int.Cl[5]
G03F 7/20

[43]公开日 1994 年 11 月 9 日

[22]申请日 93.5.5

[71]申请人 哈尔滨工业大学

地址 150006黑龙江省哈尔滨市西大直街166号

[72]发明人 武世香 邹 斌 陈士芳

[74]专利代理机构 哈尔滨工业大学专利事务所

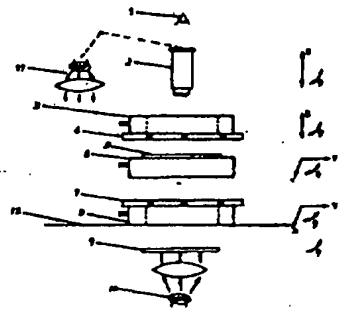
代理人 黄锦阳

说明书页数: 附图页数:

[54]发明名称 双面对版曝光机

[57]摘要

本发明双面对版曝光机，采用真空吸盘作为上下掩膜版的固定和可调整对准的机构，利用吸附原理将掩膜版吸在吸盘上，每个吸盘可作多个自由度的调整，具有两个曝光光源并包括一个显微镜。本发明双面对版曝光机可由普通的单面光刻机改造而成。本曝光机可用于制作需双面曝光的各种集成压力传感器和其它半导体器件，以及其它需进行双面图形对准加工的片状材料加工。可曝光硅片最大直径为 40 毫米，对准偏差小于 10 微米。



权 利 要 求 书

1、一种双面对版曝光机，包括：

一个显微镜[2]套装在一个固定于台架[12]上的立轴上，可绕轴水平转动和沿轴向上下移动；

一个用于曝光的上光源[11]，是由普通电光源形成的平行光源，该光源与显微镜[2]成一固定角度装在同一个立轴上，上下高度可调整且可绕轴水平转动；

本发明的特征在于还包括：

一个上掩膜版吸盘[3]通过悬臂安装在一个可垂直运动的蜗杆上，该蜗轮蜗杆系统固定在一个可围绕一个固定在台架[12]上的主轴旋转的支架上，吸盘[3] 为环状柱形空腔结构，上下端面镜面抛光，下端面有对称分布的小气群[13]，侧面安装气嘴[14]使空腔与抽气泵连通，抽气泵通过气嘴抽气，使空腔[15]产生负压将上掩膜版[4]通过气孔群[13]吸附固定在吸盘[3]上并随之绕轴旋转和上下移动；

一个硅片吸盘[6]，为圆柱空腔结构，上端面镜面抛光并有小气孔群[16]，侧面安装气嘴[17]使空腔与抽气泵连通。硅片[5]靠抽气泵抽气使空腔内产生负压吸附在吸盘[6]的上端面，吸盘[6]安装在台架[12]上并可沿x或y方向水平微动和水平自旋；

一个与上掩膜版吸盘[3]结构相同的下掩膜版吸盘[8]，上端面镜面抛光并有对称分布的气孔群，吸盘[8]安装在台架上，可水平x、y方向微动和自旋；

一个下光源档板[9]和下光源[10]，档板[9]与上光源[11]同轴安装并联动，下光源[10]亦为普通电光源形成的平行光源，位于台架[12]的下面下掩膜版吸盘[8]的垂直下方。

说　　明　　书

双面对版曝光机

本发明涉及一种曝光机，具体地说是一种用于硅片正、反两面进行掩膜曝光用的双面对版曝光机。

双面对版曝光机用于对硅片及其它需要正反面对准加工的不透明片状材料的双面图形复印。目前国内外有关的技术及设备归纳如下：

1、利用红外光刻机进行双面对准曝光，操作时先在晶片的一面加工出所需的图形，然后利用红外线在晶片中一定的穿透能力，将已加工出的图形映照在另一面，再利用掩膜进行对准曝光。参见R.A.Heinz et al, SOLID STATE TECHNOLOGY/August 1978 P55-60 和Dr Roy L. Maddox SOLID STATE TECHNOLOGY/February 1979 P57—59。这种方法的不足之处在于：

①红外显微镜观察条件差，图形反差小，图形对准慢且不够精确，低于一密耳(25.4μm)的对准偏差难以实现；

②红外线穿透能力有一定限度，当需要对准的晶片厚度超过一定值时，将很难甚至得不到清晰可辨的图形；特别是需要同时看清正反面不等距离的图形就更加困难；

③国外一台红外光刻机价值数万美元，一般厂家无力承受；

④不能用于不透红外光的基片。

2、用定位匣实现双面对准，这种方法是予先将两块镜面对称的掩膜版固定在有绞链结构的版夹上。下掩膜版上附有

定位槽，硅片沿定位槽安放并固定在两掩膜之间。可单面依次曝光或双面同时曝光。这种装置的主要优点是硅片可直接定位，减少了工序。其存在的问题是：

①由于定位槽宽度不可调，对硅片外径尺寸要求严格，且要求规格一致；

②很难保证上、下版精确对准及固定；

③硅片安放时是沿定位槽滑到下掩膜版面上的，增加了对掩膜的磨损，降低了掩膜寿命；

④在版夹铰链重复开合过程中难以保证版的位置不发生相对移动。

3、采用定位螺栓实现双面对版：此处两块掩膜版的定位由定位螺栓完成。具体做法是先制好其中的一块版A，与另一待制版B二者同时用定位螺栓固紧，通过A对B曝光，得到相互对称的两块版，操作时将双面涂好胶的硅片置于两掩膜之间，两掩膜按照制版时的方位将定位螺栓定位，固紧。可单面依次曝光或双面同时曝光后进行刻蚀。参见RICHARD M. WHITE et al, Sensor and Actuators, 13(1988)391-395。这种方法引入对准偏差的可能性在于：

① 待制版B曝光后，若定位螺栓或掩膜版侧面被杂质沾污或沾污状态及程度发生变化，则会导致二掩膜版位置错动；

②制版时和用版对硅片曝光时，两掩膜版对螺栓的靠紧程度不同；

③硅片厚度或光致抗蚀剂厚度变化导致的上、下版与螺栓接触点位置的改变；

④在制版或使用过程中掩膜版衬底玻璃的侧面或不是一

个规整的平面、或版侧面产生即使很小的边缘破损，都会导致两版图形的错位。

这种方法的不足之处在于：

①硅片的定位也要靠定位螺栓，故要求其有足够长的定位面。既增加了对硅片的加工要求，又降低了硅片利用率；

②定位螺栓直径的微小波动，特别是安装垂直度的微小偏差，均会使两版中夹有硅片时产生图形错动；

③硅片上的图形排列必须保证与定位面严格平行，增加了制版难度；

④只能用于对一次氧化后无图形光片上的双面对版曝光，不能实现版上图形与片上图形之间的对准。

4、机械式双面光刻机：这种光刻机的关键是配有双面曝光夹具。上版固定在版夹上，版夹可X.Y.Z三维运动，下版可上下移动并可沿同心轴转动，二版均有对准标记，操作时将硅片置于二版之间，对准二版之标记，夹紧后可上、下光源同时曝光。参见潘明瑞、半导体技术1987.1，P.7。其不足之处在于：

①硅片在二掩膜版之间不可随意移动，均也只能用于一次氧化后的无图形硅片曝光；

②对版时需同时看清上、下两版上的标记，对显微镜景深要求较高。对硅片厚度超过400μm者还需改造其中一个目镜镜头，通过两个放大倍数不同的目镜分别观察上、下两版的对准标记。此时两眼所看到的两个标记大小不等。显然这是难以用肉眼精确对准的，且增大了人为因素；

③无法实现单晶片的晶向定位，故无法用于各向异性腐

蚀时的对版曝光。

本发明目的是提出一种新的曝光机原理，该曝光机可以使上下掩膜版精确对准，其对准偏差小于10微米，从而完成硅片的双面对准曝光；本发明的另一个目的是提出一种结构简单、成本低廉、操作方便、一机两用的双面对版曝光机。

本发明双面对版曝光机包括：

一个显微镜[2]套装在一个固定于台架[12]上的立轴上，显微镜[2]可绕轴水平转动和沿轴向上下移动；

一个用于曝光的上光源[11]，是由普通电光源形成的平行光源，该光源与显微镜[2]成一固定角度装在同一立轴上，上下高度可调整且可绕轴水平转动；

本发明的特征在于还包括：

一个上掩膜版吸盘[3]通过悬臂安装在一个可垂直运动的蜗杆上，该蜗轮蜗杆系统固定在一个可围绕一个固定在台架[12]上的主轴旋转的支架上。上吸盘[3]为环状柱形空腔结构，上下端面镜面抛光，下端面有对称分布的小气孔群[13]，侧面安装气嘴[14]使空腔与抽气泵连通，抽气泵通过气嘴抽气使空腔[15]产生负压将上掩膜版[4]通过气孔群[13]吸附固定在吸盘[3]上并随之绕轴旋转和沿轴上下移动。

一个硅片吸盘[6]，为圆柱空腔结构，上端面镜面抛光并有小气孔群[16]，侧面安装气嘴[17]使空腔与抽气泵连通。硅片[5]靠抽气泵抽气使空腔内产生负压吸附在吸盘[6]的上端面，吸盘[6]安装在台架[12]上并可沿x或y方向水平微动和水平自旋；

一个与上掩膜版吸盘[3]结构相同的下掩膜版吸盘[8]，

上端面镜面抛光并有对称分布的气孔群，吸盘[8]安装在台架上，可水平x、y方向微动和自旋；

一个下光源挡板[9]和下光源[10]，挡板[9]与上光源[11]同轴安装并联动，下光源[10]亦为普通电光源形成的平行光源，位于台架[12]的下面、下掩膜版吸盘[8]的垂直下方。

工作时首先将镜面对称(图形或特定标记)的两掩膜版药面相对置于下版吸盘上，接通下版真空通道吸附下版；落下上版吸盘吸起上版，两版之间的距离以不产生药膜摩擦为限。在显微镜下移动或旋转下版，使之与上版对版标记完全重合。之后二者均不能再有水平面上的微动。上提上夹具，其高度以附带有硅片的吸盘能进入二掩膜版之间为限。将硅片送入二版之间后落下上吸盘，使上版与硅片轻轻接触，移动并旋转硅片，使之与上版图形对准。盖上上吸盘上盖，使上版·吸盘中腔接通真空系统，通过上版气孔将硅片吸在上版下面，将硅片吸盘气路放气，此时上提上版，硅片即随同上版一同提起。撤回硅片架，落下上版吸盘，直到硅片下面接触下掩膜版。打开上吸盘上盖，旋开显微镜并使上光源对准硅片曝光，与此同步，下挡板旋开，下光源对硅片下面曝光。经显影后即可得到正反两面对准的图形。

随着计算机的发展和自动化程度的提高，传感器的地位越来越为人们所认识和承认。而固态传感器又以其体积小、重量轻、耗电省等一系列优点在传感器家族中占据着独特的位置，并将随其制作水平及各项性能指标的提高拥有日益扩大的市场。作为固态传感器重要的和主要分支的力学量传感

器和某些化学量传感器，在其加工制作过程离不开双面加工，因而用于双面加工的红外光刻机及各种专用夹具、模具等也即应运而生。本发明型双面对版曝光机正是在这种情况下，在研究、比较了国际国内的有关技术之后研制出的适合工业应用的、具有很高实用价值的双面加工设备。

该双面曝光机可由原有的单面光刻机改装而成。下版吸盘安装在原版夹微动系统位置上，原版夹微动系统改为硅片吸盘微动系统增加上版吸盘和硅片吸盘及所需的移动，转动部件；增加一个同上光源相同的下光源系统，外配一个直筒式显微镜。

该机的特点是：

1、上版有两个自由度，硅片及下版均有3个自由度，互相独立，操作灵活；

2、可以在任意中间工序实现晶向定位及图形的双面对准，不受硅片上有无图形的限制；

3、对硅片尺寸及形状，规格无特殊要求；

4、显微镜本身有两个自由度，可保证观察图形时垂直对准，并扩大了显微镜的视野，可缩短对版时间；

5、一机两用，只需关闭下光源即可做单面光刻机使用；

凡是有单面光刻机的厂家均可花费几千元（关键取决于所选配的显微镜的档次）即可获得目前尚无有出售的双面对版曝光机。扩展了设备功能，且不致产生闲置设备。

已改制成的双面对版型曝光机，微动机构采用钢件构成，上、下版吸盘采用合金铝制成，可曝光硅片最大尺寸ϕ40mm，满足半导体压力传感器上下对准偏差$<\pm 10\mu m$的要求，用此

机制作的 cy-yz-Ⅰ型硅集成压力传感器其各项技术指标均已达到设计指标。

若采用球形汞灯聚光系统，加大平行光柱面积，曝光面积可根据需要增大，基本工作原理不变。

图1为本发明双面对版曝光机的工作原理图；

图2为上掩膜版吸盘的结构原理图；

图3为硅片吸盘的结构原理图。

说　明　书　附　图

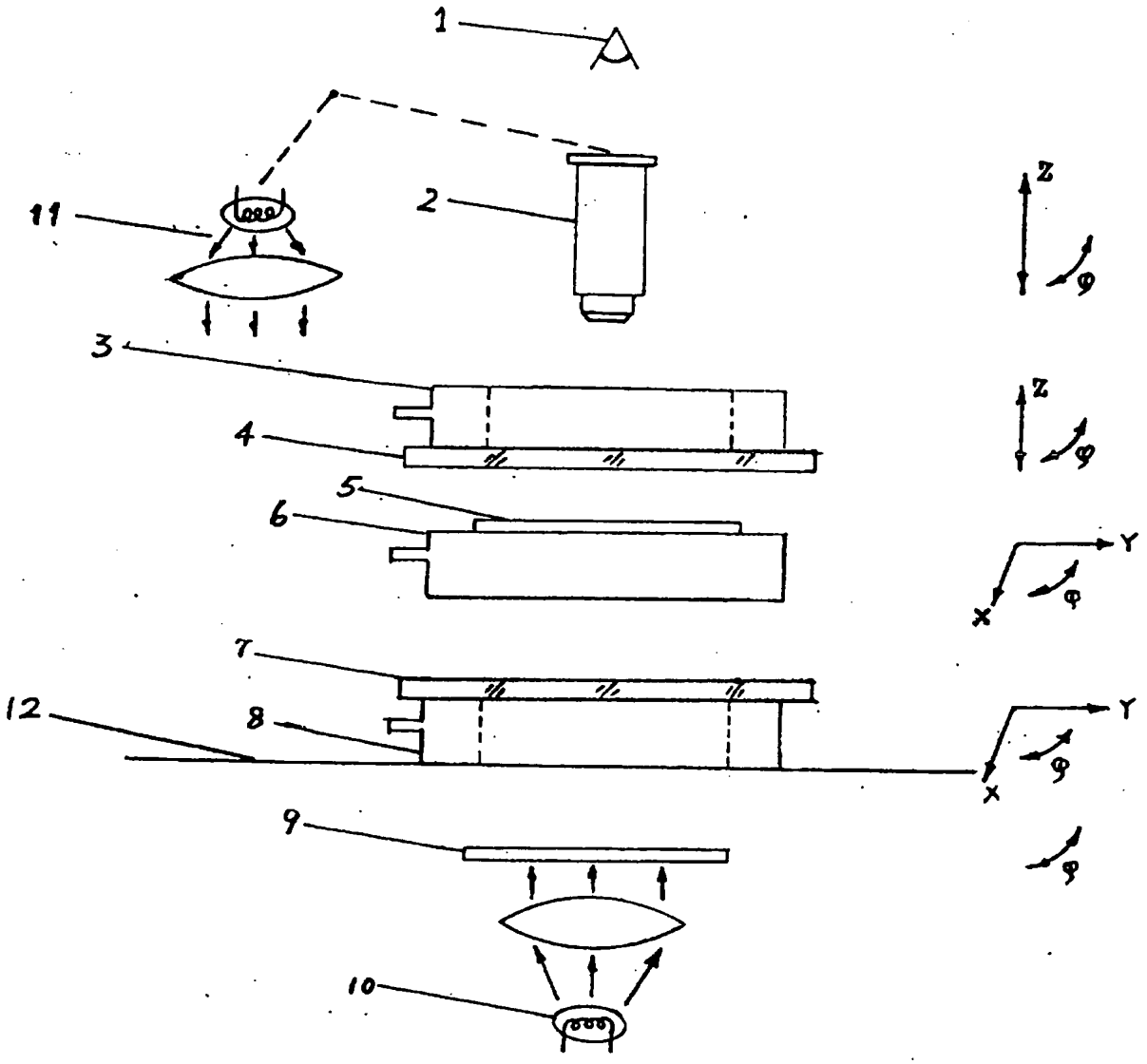


图 1

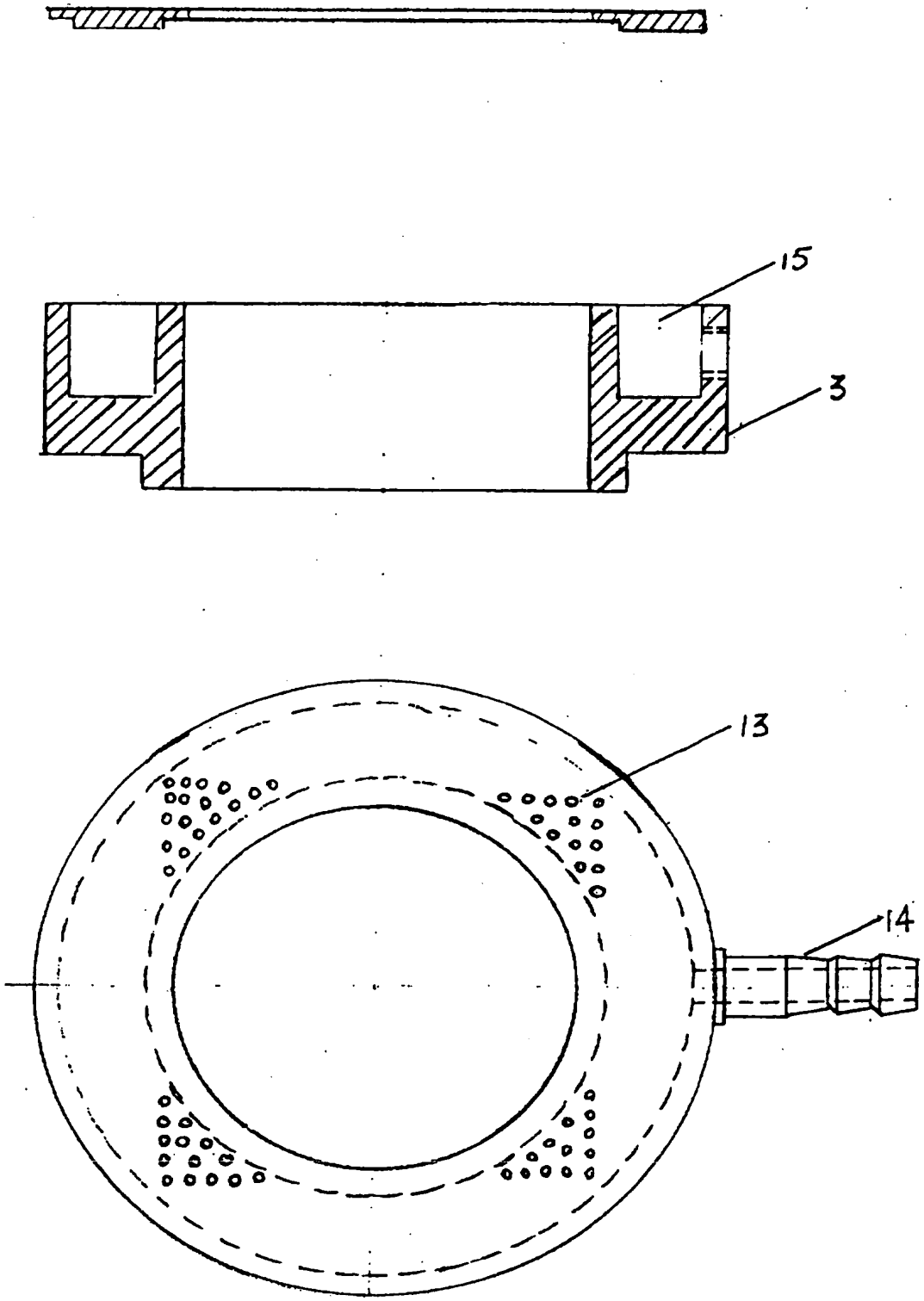
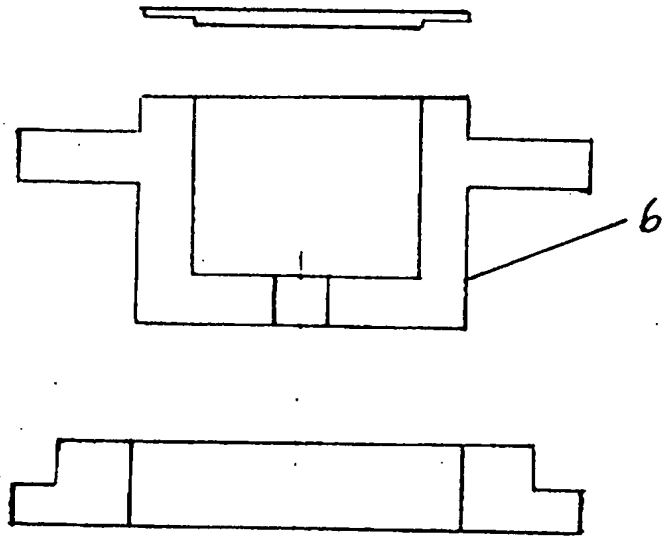
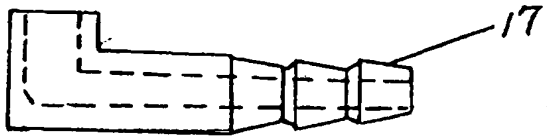


图 2





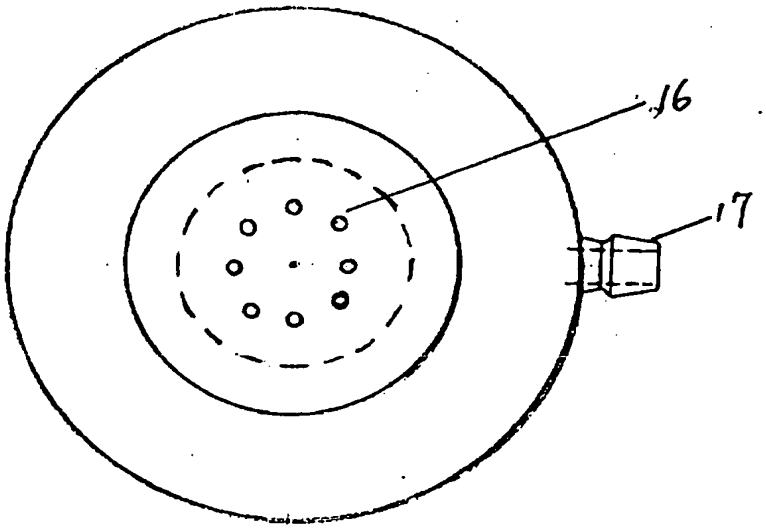


图 3